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THE NATURE OF RECOGNITION MEMORY AND OF THE LOCALIZATION OF RECOGNITIONS¹

By MARGARET HART STRONG and EDWARD K. STRONG, JR.

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I. INTRODUCTION

Professor Woodworth² has said, "It is worth noting that the feeling of familiarity varies in *quality* as well as in intensity. A person may arouse in us a feeling of having been recently seen or of having been seen a long time ago, of having been seen under agreeable circumstances, or of having stood in some definite relations to us, as of co-operation, antagonism, etc. No experimental study has yet been made of these varieties of the feeling of familiarity." Wundt³ has also maintained that each act of recognition "possesses its own peculiar quality." Lehmann⁴ pointed out that recognition has two meanings in daily life: (1) to recognize, knowing you have seen previously, but not knowing where; and (2) to recognize, knowing you have seen previously and knowing where, when, etc

In this paper we have attempted to obtain a better conception of what is involved in those qualities which seemingly can be thought of as added to the apparently simple process of recognition, or, in Lehmann's words, to discover what is involved in the process of knowing where, when, etc., one has seen the object before, as distinguished from simply knowing that one has seen it.

¹ Read in part at the Chicago meeting of the American Psychological Association, December, 1915.

² R. S. Woodworth. Mimeographed lecture notes on recognition memory, Summer School of 1913, p. 63.

³ W. Wundt. *Introduction to Psychology*, p. 105-107.

⁴ A. Lehmann. Ueber Wiedererkennen, *Philos. Studien*, V., 1889, 96-156.

We have attacked here specifically the problem of how one localizes the previous experience of an object, as well as how one recognizes that object. From our results we believe that localization may be due either to some affective process, or to a system of associational reactions which link the object with other objects whose time-relations are known. The latter type of localization is with us introspectively different from the former, and we are not concerned with its analysis here. The nature of the mental process in the affective type of localization is not very clear, as the result of this study; but we are inclined to believe that it is essentially a finer subjective analysis of the same consciousness that conditions recognition itself.

We present first our experimental results which throw some more light on the process of recognition, as well as on the process of localization itself; then we pass to a general discussion of the nature of recognition and finally to that of localization.

II. THE EXPERIMENT

The same general procedure was followed here as in the experiments reported in our 1913 *Psychological Review* article.⁵ In that investigation we used lists of 20 words which were read through at the subject's leisure, *i. e.*, "he was told that he might read them slowly enough to actually grasp the meaning or content of the word, but must read them fast enough not to be able consciously to form associations between them." After a certain interval of time a reaction list was presented containing the first 20 words and 20 new ones. The subject was asked to check the words he recognized as having been seen in the stimulus list. He indicated the certainty of his recognition by marking a "1" opposite words he was absolutely sure of, a "2" after words he was reasonably sure he had seen, a "3" after words he had a faint idea he had seen, and a "4" after pure guesses. A "4" was necessary because the subject was required to check 20 words each time. (For further details of the procedure, see article in question.)

The present investigation employed the above procedure and three other procedures, all variations of the first. In Experiment A the above procedure was used, a stimulus list being given on Sunday and the reaction list on Wednesday, four days later. On the same day the second stimulus list

⁵ E. K. Strong, Jr. The Effect of Time-Interval upon Recognition Memory, *Psychol. Rev.*, XX., 1913, 339-372.

was given and the reaction list followed two days later on Friday. The third stimulus list was then given and its reaction list followed on Saturday. The fourth stimulus list was then given and its reaction list followed five minutes later. From Experiment A we can determine the effect of time-intervals of 4 days, 2 days, 1 day, and 5 minutes on recognition memory. These results can be compared with those obtained for these intervals of time in the 1913 *Psychological Review* article.

Experiment B was similar to Experiment A except that the stimulus lists were presented on Sunday, Tuesday, Wednesday and Thursday mornings, and then all four reaction-lists were reacted to at the same time.

Experiment C differed from Experiment B in that the entire 160 words were jumbled up into one long reaction list instead of four shorter lists. In Experiments A and B the subject knew that the reaction list contained 20 old and 20 new words and he knew just how long a time had elapsed since he had previously seen the old words. In Experiment C he knew that the reaction list contained 80 old and 80 new words, but he was not informed as to how long an interval of time had elapsed since he had seen any specific word.

Experiment D differed from Experiment C in that the reaction list contained only the 80 old words and no new words. There was no check here on the subject's recognitions and of course he knew that all the words in the list should be checked with a "1." But the experiment was run to see just how knowledge that all the words had been seen before would affect recognition.

Now besides the above phases of this investigation dealing with *recognition* there were two further parts dealing with *localization*. After the subject had marked the lists in Experiments C and D for his recognitions he was required to mark opposite each word when it had been previously seen and also just what degree of certainty he had of this localization.

The two writers acted as experimenter and subject for each other. Five complete records were obtained in each of the four experiments. This made a total of 80 lists used on each subject, or a total of 160 lists in all, involving the use of 6,400 different words. Experiments A, B, C and D were run in an irregular order so that the subject did not know, at the start, with which experiment he was being tested. This irregular order was planned, however, so that the practice effect would be evenly distributed among the four types

of experiments. The experiments were run during the winter of 1913-1914.

1. *Results Involving Recognition Memory*

In Table I are given the results from the four experiments segregated so as to show the effect of the four different intervals of time upon recognition. Each record for subjects *A* and *B* is based on five determinations, while the records for the average of the two are based, of course, on ten determinations. All these records are based on the correct recognitions that were made and no account is taken here of any incorrect recognitions. Experiments C and D were run primarily to study localization and do not lend themselves to an accurate estimation of the incorrect recognitions,—in Experiment D, of course, none being possible. It is fair to compare the four experiments in terms of these figures, although it must be understood that they are all too high to represent true recognition, as they are composed of two components, (1) true recognition and (2) pure chance. In Table II we have the records of Experiments A and B corrected for incorrect recognitions.⁶ These data may be compared directly with the 1913 article. In Table III are given the latter data for 5 minutes, 1 day, 2 days, and 4 days, together with the gain made in the present investigation over the 1913 investigation.

a. *Practise Effect in Recognition Memory.* A study of Tables II and III and Curves Ac and 1913 in Plates I and II shows a most decided gain in recognition memory ability. In fact, the gain is very surprising. The introspections reported by the subjects do not indicate that they were aware of any particular progress in this regard. At the start (including the first 20 lists) subject *A* did not feel that she was doing so well as in the earlier work. After lists 21-24 had been marked she reported that she had “quite gotten back to her method of associations as in the old experiment.” This set was interesting because of the sureness with which she recognized. She went through no list twice, but “just put down 1, 2 and 3 as they came along.” To what extent a person could develop his ability to recognize is an interesting problem. Apparently it can be developed very much more and very much more easily than recall memory. It is also

⁶ See the 1912 and 1913 articles for a discussion of the methods used in these determinations. (See note 10 for reference to the 1912 article.)

interesting to note that subject *A*, who was markedly superior to subject *B* in all these tests, improved at least twice as much as did subject *B*. The result we are finding in all our work in psychology today holds good here also;—"to him that hath it shall be given."

b. Various Methods of Studying Recognition and their Effects on the Process itself. A comparison of the results in Experiments A and B (shown in Tables I and II and in Plates I and II) indicates that a larger number of recognitions can be made when one list is being tested at a time than when four lists are tested at the same time. Methods which involve presenting several lists at one time to be tested later at various times, or which involve presenting lists at various times to be all tested later at the same time, will, then, not give so high a percentage of recognitions as when one list is presented and tested before the second is taken up. The difference in the two methods affected the poorer subject (*B*) more than it did the better subject (*A*), actually on the average 7.6% as against 2.4%.

Upon studying the data of Experiments B and C it is apparent that there is no real difference between the results. If anything, the results in Experiment C are higher than those in Experiment B. This is rather surprising when it is realized that in Experiment B one knows just how old the 20 correct words in the list he is marking are, whereas in Experiment C the 80 correct words vary in age from 5 minutes to 4 days. It would seem from these figures that recognition is not affected by any sort of mind-set in which one adjusts himself to a certain age of the recognitions. Meyer⁷ has found that preparedness favors the process of recognition. But his preparedness was quite different from that considered here. In his case he found that a word was better recognized if it followed the 'old' syllable which was its immediate antecedent in the learning series, than if it did not follow such an antecedent word. Our data would also support this view. Such preparedness can be based on the fact that because the first word came first certain associations were aroused by the second word that would not normally arise and so in the test the presence of the first word would aid in the same association again coming to mind when the second word was again encountered. But no such specific aid is to be thought

⁷ H. W. Meyer. *Bereitschaft und Wiedererkennen*, *Zeitschr. f. Psychol.*, LXX, 1914, 161-221.

of when one prepares to meet words a day old, or an hour old, as distinguished from words but five minutes old.

If these results were characteristic alone of subject *A* they might be explained on the ground of a difference in attitude toward the two experiments. Subject *A* reported that in Experiment C she considered the recognitions as being of subordinate importance to the localizations. Consequently she marked the recognitions as her first inclination directed, whereas in Experiment B the recognitions were considered the important thing and there she took few chances. But as both subjects *A* and *B* reacted in the same way toward Experiments B and C, it is doubtful if the above attitude explains the findings here.

It is very clear from the tables and plates that a higher percentage of recognitions can be made in Experiment D than in Experiment C. In the former the subject knew that he had seen before all of the 80 words in the list, whereas in the latter he knew that he had seen before only 80 of the 160 words in the list. When the data are analyzed it is found that this result is not due to a greater number of guesses or judgments with a faint idea of being correct being made, but is due mainly to a larger number of "absolutely certain" recognitions being made in Experiment D than in Experiment C. In the case of subject *A* 55% of the possible recognitions were absolutely certain ones in Experiment C and 62% in Experiment D; in the case of subject *B*, the corresponding figures were 32% and 45%. That knowledge that you couldn't make a mistake should affect the absolutely certain recognitions of trained subjects is an interesting fact. It may be, however, as suggested below, that if we could calculate the true recognitions aside from mistaken and chance ones that there would be little difference between the two experiments.

c. Conclusion. Recognition memory is susceptible of an enormous amount of improvement. This improvement is due, as was pointed out in the 1913 article, to improvement in reacting to the stimulus words and to improvement in methods of estimating the certainty of one's recognitions.

Recognition is more successful when one test is finished before starting the next. It apparently is more successful when one knows he can't make mistakes. And from our figures it appears that one can recognize words of varying ages mixed in together just as well as when they are segregated into groups all of the same age. That is, that a mind-set regarding the age of the words to be reacted to is not of

advantage in recognition. If this is true, it would further distinguish the process of recognition memory from that of recall memory.

2. *Results Involving the Localization of Recognitions*

The localization discussed here refers specifically to the ability to tell whether a particular word had been seen 4 days, 2 days, 1 day, or 5 minutes ago in a list of 20 words, a list which had been read through but once. The 80 words that were judged were composed of 20 words from each of the four stimulus lists. In Experiment C they were mixed in with 80 new words, while in Experiment D they entirely constituted the reaction list. In the latter test there was no opportunity to make a mistake in recognizing the several words in the list of 80, but there were three chances in four of mistaking how long ago the word had been seen.

In Table IV is shown the per cent of words that were localized correctly in the two experiments for the four different intervals of time. In Table V the same information is given, but here based on corrections for all incorrect localizations. The first line in this table means then that 88.8% of the 20 words tested 5 minutes after reading them were really localized correctly as being in that list in Experiment C by Subject A. Likewise 91.3% were correctly localized by that subject in Experiment D. The minus per cent (-1.0) in the case of Subject B, Experiment D, for 2 days means that he made more incorrect localizations than correct localizations.

It is clear from these tables and Curves CL and DL in Plates I and II that ability to localize when an interval of 5 minutes is considered is nearly, if not quite, synonymous with ability to recognize when an interval of 5 minutes is considered. This fact is more clearly realized if we compare the ability to localize as found here with the ability to recognize as found in the 1913 article (Curves 1913), as well as with the results obtained in this article (Curves A and B). The ability to recognize shown in the latter curves represents far more training than the ability to localize shown in Curves CL and DL. But now when we compare recognition and localization for other intervals of time than 5 minutes we find that ability to localize fades out very much faster than does the ability to recognize. It is only natural to expect this. In recognition one needs to know only that he has seen the word before; in localization one needs to know not only that, but also just when one has seen the word.

One of the writers feels that the results shown here as to localization mean that the ability fades out just as does that of recognition, only faster, and that if we had data for intermediate intervals of time they would fit into our present data. The other writer believes that the words in a list with the shortest interval of time under discussion at any time will be localized very efficiently, that the words in the list with the next shortest interval of time will be localized with only a small degree of accuracy and from then on the localizations will be practically nil. In other words the latter believes that if the intervals had been 5 minutes, 1 hour, 2 hours, and 4 hours instead of 5 minutes, 1 day, 2 days, and 4 days, practically the same results would have been obtained for the first series of intervals as were found for the second series.⁸ Which view is correct must be determined by future experimentation

From Table I it is clear that more correct recognitions are made in Experiment D than in Experiment C. In Table IV this same relationship is maintained as to localizations. But when corrections are made for the incorrect localizations which were made (shown in Table V) it would appear that there is no particular difference in the number of localizations that can be made in the two experiments. This fact that there were a greater number of mistaken localizations in Experiment D than in Experiment C suggests that if we had a way of estimating the mistaken and chance recognitions in both experiments that possibly there would be little or no difference in the results from the two experiments.

In Table VI is shown the per cent of correct localizations, correcting for incorrect ones, which can be made according as the recognitions, upon which they are based, are "absolutely certain," "reasonably certain," "faint," or "pure guesses." From these results it is clear that almost all true localizations are based on absolutely certain recognitions. It is also true that when the recognitions are incorrect the localizations that are made are very seldom accompanied by a higher degree of certainty than a "3"—"faint certainty." *Localization is then dependent on the same factors that constitute absolutely certain recognitions.*

As far as introspections go in this matter it would appear that the localizations were largely made in terms of events

⁸ This article has been withheld from publication for two years in the hope that this point might be cleared up before reporting the experiments, but as it seems impossible to find time to complete the necessary experiments, it is now published as it is.

that happened on the day the words were read. We localized the word as having appeared at a certain time because the word and its associations had something to do with the events which had accompanied reading that list, i. e., a word called up a kitchen utensil and we remembered that we had been in the kitchen while reading the list, hence the word belonged to the list read on that day. However, the mental process was different from this analysis in that one did not ordinarily go through these steps in making his localization but seemed merely to be aware of the whole thing. The awareness, however, was very often reinforced by argument of this sort. In a few cases certain words were recognized as having been seen together in the same list and so if anyone was localized definitely, the others were then localized. But this manner of localization did not have the same sort of consciousness as the first type referred to and one felt as though he was making an intellectual judgment after weighing evidence rather than simply localizing.

III. GENERAL DISCUSSION

1. *Concerning the Nature of Recognition.* Feingold⁹ finds that "recognition ability varies inversely as the number of objects perceived," "inversely as the number of objects exposed," and "directly as the temporal length of perception." These conclusions are true in his experiments where only a few items are being studied and where the exposure-times are very short, but they are not strictly true when the conditions of experimentation are changed so that many items (20 to 150) are being studied or where the exposure-time is relatively long. As regards the first two statements it has been found¹⁰ that as you increase the number of objects presented the number recognized is decreased, but the rate of decrease is much slower than the rate of increase in the number of objects presented. It is not an inverse proportion. As regards Feingold's last statement, we have found that this is true as one increases the exposure-time from one to two or three seconds per object shown,¹¹ but that it does not hold

⁹ G. A. Feingold. Recognition and Discrimination, *Psychol. Rev. Monog.*, 1915, No. 78.

¹⁰ E. K. Strong, Jr. The Effect of Length of Series upon Recognition Memory, *Psychol. Rev.*, XIX, 1912.

¹¹ Exposure of 1 advertisement per 1.0 second resulted in 2.1% of the advertisements being recognized, whereas exposure of 1 advertisement per 3.5 second resulted in 6.3% of the advertisements being recognized. (E. K. Strong, Jr. The Effect of Size of Advertisements and Frequency of their Presentation, *Psychol. Rev.*, XXI, 1914.)

in anything like a direct proportion after that interval of time. In an experiment in which 25 advertisements were shown (1) at rate of one per second and (2) at the leisure of the subject—amounting to at least 5 seconds—the subjects being required thereupon to recognize cut-up pieces of the original advertisements mixed in with cut-up pieces of new advertisements, in the first case 17.3% of the pieces were recognized and in the second case but 34.2% of the pieces were recognized.¹² The relationship here between exposure-time and number recognized is far from a direct proportion. We would suggest that the conclusions of Feingold and ourselves probably show that until the subject has time to clearly perceive what is before him there is something like a direct proportion between efficiency in recognition and exposure time and an inverse proportion between efficiency in recognition and the number of objects exposed, but that as soon as the time exceeds this amount the proportion between efficiency in recognition and exposure-time, or inversely as the number of objects exposed, becomes less and less a direct proportion. Possibly one might say that Feingold's conclusions cover conditions involving maximum attention, whereas ours are based on conditions so extensive as to make impossible such a state of attention throughout the experiment.

Feingold also reports that the "recognitive ability varies inversely as the degree of similarity" between the first percept and the substituted one, that "the process of recognition is affective and is independent of cognition," and that "the feelings of familiarity and strangeness inhibit each other by fusion." According to his view these things are so since a stimulus-word arouses from one to many associations when it is seen the first time and it calls up again the first set of associations, only some of them, or none at all, according as the reaction word is similar to the first or not in mechanical make-up or meaning. If the stimulus-word and the reaction-word are identical then the nervous current traverses the same pathways a second time. Recognition results. If the reaction-word is different the nervous current traverses new pathways. Under the conditions of Feingold's experiments where eight words were shown each time, the feeling of strangeness is experienced. When the reaction-word is to some extent similar to the stimulus-word then we have a blending or fusion of the feelings of familiarity and strangeness according as part

¹² E. K. Strong, Jr. An Interesting Sex Difference. *Ped. Sem.*, XXII, 1915, 521-528.

of the second discharge traverses part of the former pathways and part traverses new pathways.

This fits in exactly with the speculations of the writers. In the 1913 article the process was likened to an electric current in that "if the current does not flow somewhere there is no current in the wire." And later it was suggested that "the recognition is more likely made while the accompanying associations are coming to consciousness the second time." All of this suggests Höfding's theory that recognition was due in some way to an increased "ease" of nerve functioning.¹³ Having no evidence to support this notion of "ease" our speculations were not presented. Since then, during March, 1914, the following experiment was carried through which seems to throw some light on the subject.

Lists of 20 rather difficult words were made up. They were read one at a time by the experimenter to the subject who responded according to the free-association procedure. The reaction time was measured by a stop-watch. As few of the reaction times were less than one second, due to the unfamiliarity of the words used, the stop-watch gave us fairly reliable figures. Another list of 60 words made up from three of the 20-word lists was read later so as to come 5 minutes after one of the shorter lists, 1 hour after another, and 1 day after another. A comparison was then made as to the gain or loss in reaction time according as the response was *identical*¹⁴ the second time with the first response or different from it. A and B served again as experimenter and subject on each other. At this time they were experienced subjects in the free-association experiment. The data indicate that there was a decrease in reaction time of 0.10 seconds when

¹³ H. Höfding. *Zur Theorie der Wiedererkennen. Phil. Stud.*, VIII, 1893, 86-96.

¹⁴ It has seemed best to consider in this experiment only those cases where the responses in both cases were identical. But in doing so we realize that recognition would have taken place in many of the other cases. We had in the experiment responses the second time (1) that were identical with the response the first time, (2) that were similar (in sound, meaning, etc.) to the first response, and (3) that were entirely different. Where to draw the line between the second and third group is a difficult matter. In many cases it cannot be done with certainty. For example, the first response to "kitchen" is "stove" and the second time it is "range." The subject reports that both "stove" and "range" were in mind both times but they appeared in reversed order. In such cases recognition would undoubtedly have occurred. But there are other combinations logically similar to this one for which the subject had no explanation. In order to be on the safe side, then, only those cases were considered where there was an identical response in both cases.

the same reaction word was given again to a particular stimulus one day later, this decrease was 0.18 seconds when an hour intervened, and 0.24 seconds when but five minutes intervened.

For Subject *A* the medians were, respectively, 0.11, 0.17, and 0.25 seconds, and they were for Subject *B*, respectively, 0.10, 0.20, and 0.23 seconds.

Now what has all this to do with recognition memory? If recognition is due to the arousal a second time of certain associational pathways and it is due to the increase in "ease" of the nervous discharge, then why may not this ease be a function of the speed of discharge, and if so, would not there be a corresponding increase in the rate of discharge with the per cent of recognitions that can be made? Now this is apparently what we find in this free-association experiment. In the 1913 article we find that

72.7%	of 20 words	are recognized after	5 minutes,	A ratio of	100 to
57.3%	"	"	1 hour	"	79 to
28.8%	"	"	1 day	"	40.

and in the same way, we find that there is a gain in reaction-time of

0.24	seconds	when the association	is repeated after	5 minutes,	100 to
0.18	"	"	"	1 hour	75 to
0.10	"	"	"	1 day	42.

The relationship between recognition ability for these three intervals of time and the difference in association time for the two reactions for these intervals of time is identical.

Just what does all this mean? We have carried on the free-association experiment in such a way (only considering the cases where the responses were identical) that all the objective requirements for recognition have been fulfilled. Then we find that the differences in reaction-time between the two presentations with various intervals of time correspond exactly with the ability to recognize with those same intervals of time. Put in other words we have found that there is a direct relation between fading recognition and decrease in the gain of association time for a second trial. May we not say then that recognition is based on the "ease" with which the nervous current discharges the second time as compared with its discharge the first time. And if so, we must say that this element of ease is objectively measured largely, if not entirely, in terms of reaction-time. It is estimated subjectively in terms of the consciousness of recognition.¹⁵

¹⁵ It may be urged against these results that they are only a coincidence. Possibly this is true. We realize that this new evidence of

We can have the following situations involving recognition memory:—the first reaction to a stimulus, the second reaction to the same stimulus, the third reaction, . . . the *n*th reaction. We know that as we proceed from the 1st to the *n*th reaction the reaction-time will steadily drop (practise-effect). We know also that accompanying the first reaction there is often a consciousness of strangeness or novelty, accompanying the second reaction a consciousness of familiarity or recognition, and accompanying the *n*th reaction a consciousness of extreme familiarity, but different from that of recognition. As an example of this extreme consciousness of familiarity is the consciousness which accompanies meeting our father, our home, etc. Can we not say then (1) that when a stimulus causes a nervous discharge never experienced before we can be aware of the fact that the discharge occupies more time (or precedes with less "ease") than ordinarily and that this particular form of awareness is the consciousness of strangeness or novelty; (2) that when a stimulus causes a nervous discharge which has occurred only once, or only a few times, or a number of times a long time ago, that the discharge occupies less time than in the first case but still with more time than ordinarily and that this particular form of awareness is the consciousness of recognition; and (3) that when a stimulus causes a nervous discharge which has occurred many times it occupies about the same time that the reception of most of the things we perceive does and ordinarily there is no awareness of the "ease" element in the nervous discharge. When our attention is called, however, to this phase of the reception we experience the consciousness of familiarity, or "at homeness," characteristically different from mere recognition.

This explanation of recognition follows that of several writers. Höffding¹⁶ first stated this view when he maintained

the facilitation theory is indirect and circumstantial. Nevertheless we cannot help but believe that the experimental results do bear on the point. Our own introspections, as well as the introspections of those who know nothing of the nature of recognition, all point to a factor of ease in the recognition process. And "ease" necessarily implies less time. Other things being equal, one process cannot be easier than another without also involving the factor of being done quicker.

The term consciousness is used here as there is apparently no technical term to cover this particular case. Feingold employs the term "feeling." But there are many objections to this term, especially as psychologists have endeavored to restrict this term to the general consciousness of pleasantness-unpleasantness.

¹⁶ H. Höffding, *op. cit.*

that the perception of an old object was qualitatively different from the perception of a new object. This qualitative difference (his *Bekanntheitsqualität*) was due, he claims, to a fusion of the perception with an immediately aroused image of itself. The *Bekanntheitsqualität* is aroused because in this fusion there is an increased ease of nerve functioning. Dearborn¹⁷ and Meumann¹⁸ have also distinguished between the consciousness of familiarity and strangeness on the basis of an easiness with which the mental process proceeds.

TABLE I

Showing the percentage of twenty words that can be recognized after four different intervals of time. (No correction is made in these figures for the incorrect recognitions which were made.)

Subject A

Interval of time	Experiment A		Experiment B		Experiment C		Experiment D	
	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.
5 minutes.....	96.75	1.13	97.00	0.80	95.28	1.10	94.26	1.13
1 day.....	65.75	1.20	60.00	4.17	65.52	4.70	74.77	3.57
2 days.....	55.00	2.50	47.25	5.23	48.78	1.87	53.28	1.09
4 days.....	41.50	3.43	45.00	3.67	41.02	2.86	49.26	4.97

Subject B

Interval of time	Experiment A		Experiment B		Experiment C		Experiment D	
	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.
5 minutes.....	79.00	3.57	80.00	1.83	83.95	1.97	86.5	2.20
1 day.....	41.25	3.17	35.50	2.27	39.25	1.80	55.75	4.13
2 days.....	38.50	2.73	21.50	1.73	28.00	3.70	50.5	3.53
4 days.....	33.75	1.67	25.25	1.57	20.25	2.27	40.5	3.80

Average of Subjects A and B

Interval of time	Experiment A		Experiment B		Experiment C		Experiment D	
	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.
5 minutes.....	87.88	2.33	88.50	2.13	89.62	1.42	90.38	1.30
1 day.....	53.50	3.05	47.75	3.64	53.39	3.67	65.26	3.19
2 days.....	46.75	2.63	34.38	3.94	38.39	3.00	51.89	1.88
4 days.....	37.63	1.79	35.13	2.86	30.64	2.66	44.88	3.29

¹⁷ G. V. Dearborn. Notes on the Discernment of Likeness and Unlikeness. *Jour. Philos. Psychol. and Sci. Methods*, VII, 1910, 57-64.

¹⁸ E. Meumann. Ueber Bekanntheits und Unbekanntheitsqualität. *Arch. f. d. ges. Psychol.*, XX, 1911, 36-44.

TABLE II

Showing the percentage of twenty words that can be recognized after four different intervals of time, when a correction is made for incorrect recognitions.

Interval of time	Subject A				Subject B				Average Subjects A and B			
	Expt. A		Expt. B		Expt. A		Expt. B		Expt. A		Expt. B	
	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.
5 minutes ..	96.00	1.43	96.50	0.93	76.31	4.24	78.70	1.75	86.16	2.71	87.60	2.20
1 day.	59.89	1.48	52.97	4.22	33.04	2.88	30.67	2.23	46.47	3.58	41.82	3.44
2 days.	40.35	4.05	38.01	7.12	27.33	2.63	16.23	2.00	33.84	2.69	27.12	4.29
4 days.	33.89	2.80	34.37	3.03	27.54	1.51	16.45	1.57	30.72	1.80	25.41	3.05

TABLE III

Showing (1) the percentage of twenty words that can be recognized after four different intervals of time from the 1913 *Psychological Review* article and (2) the gain made in the present investigation over the earlier study, i.e., the difference between the data in Experiment A (Table II) and the 1913 data.

Interval of time	Subject A				Subject B				Average Subjects A and B			
	Expt. A (1913)		Gain		Expt. A (1913)		Gain		Expt. A (1913)		Gain	
	Per cent	P.E.	Per cent		Per cent	P.E.	Per cent		Per cent	P.E.	Per cent	
5 minutes ..	73.9	5.2	22.10		66.3	5.4	10.01		70.1	3.7	16.06	
1 day.	28.9	4.6	30.99		21.4	5.6	11.64		25.2	3.7	21.27	
2 days.	22.3	3.5	18.05		21.1	2.6	6.21		21.7	2.0	12.14	
4 days.	22.9	3.4	10.99		16.0	2.0	11.54		19.5	2.1	11.22	

TABLE IV

Showing the percentage of twenty words that can be localized as to when they were previously seen for four different intervals of time. (No correction is made in these figures for the incorrect localizations which were made.)

Interval of time	Subject A				Subject B				Average Subjects A and B			
	Expt. C		Expt. D		Expt. C		Expt. D		Expt. C		Expt. D	
	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.
5 minutes ..	89.25	2.20	91.75	1.63	78.5	1.37	75.0	3.67	83.88	1.59	83.38	2.56
1 day.	19.5	2.43	24.25	2.13	12.25	0.60	16.25	2.67	15.88	1.37	20.25	1.81
2 days.	3.0	0.27	4.75	1.23	4.75	0.73	7.75	0.60	3.88	0.42	6.25	0.69
4 days.	2.25	0.60	3.25	1.23	4.25	0.69	6.75	1.13	3.25	0.50	5.00	1.06

TABLE V

Showing the percentage of twenty words that can be localized as to when they were previously seen for four different intervals of time, *when a correction is made for incorrect localizations.*

Interval of time	Subject A				Subject B				Average Subjects A and B			
	Expt. C		Expt. D		Expt. C		Expt. D		Expt. C		Expt. D	
	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.	Per cent	P.E.
5 minutes ..	88.81	2.32	91.25	1.50	77.71	1.70	73.9	4.05	83.26	1.61	82.58	2.61
1 day.	17.68	2.53	19.38	1.71	10.07	0.63	10.18	2.28	13.88	1.38	14.78	1.61
2 days.	1.92	0.25	2.7	1.04	2.63	0.63	-0.97	0.77	2.28	0.34	0.87	0.61
4 days.	1.84	0.61	2.85	1.10	2.08	0.43	3.78	1.23	1.96	0.42	2.41	0.86

TABLE VI

Showing to what extent localization can be correctly made as depending on the degree of confidence of the recognition.

Certainty of recognition	Subject A		Subject B		Average Subjects A and B	
	Localization correct	Localization incorrect	Localization correct	Localization incorrect	Localization correct	Localization incorrect
Absolutely certain. . .	25.8%	0.6%	22.2%	0%	24.0%	0.3%
Reasonably certain. . .	2.5	0	0.9	0.2	1.7	0.1
"Take a chance". . . .	0	0	0.2	0.2	0.1	0.1
Pure guess.	0	0	0	0	0	0

Woodworth¹⁹ has given a somewhat similar explanation of recognition. He says, "When a fact arouses the same associations, or reactions, as it did on a previous occasion, it is recognized. It is the reaction that gives the feeling of familiarity. According to this view, it is not the associations leading to the fact, but those leading from the fact to some reaction, that lie at the basis of recognition. It is what the fact does within us that determines whether it shall be recognized or not, if it does something that it has done before, i. e., leads to the same reaction as before—it is recognized; but if it does something new—leads to a new association or new perception—it is not recognized. The recognition depends on the transition from the fact to some reaction; if this transition is one which has been frequently or recently made, it is now made with a sense of having been made before, and this is the basis of the feeling of familiarity and of the recognition." . . . "In neural terms, it is the passage of a current along a long

¹⁹ R. S. Woodworth, *op. cit.*, p. 72-73.

unused brain path or synapse that gives the feeling. The passage of a synapse *feels* differently, according as it is constantly in use, has never been used, has only recently been used, or has been much used at some earlier time but has since fallen into disuse."

It seems to us that most writers who have espoused the facilitation theory have laid themselves open to the criticism that the facilitation theory does not help us on the side of consciousness by their not making an attempt to correlate "ease" with "consciousness."²⁰

Woodworth answers this objection by postulating that the passage of a current across a synapse *feels* differently according to the degree with which it has been used. We state the same thing a little differently by stating that the rate of discharge of the current across the synapse has a conscious correlate in the varying qualities of consciousness, i. e., of strangeness and familiarity. With us there is no greater difficulty in saying that when certain cells or synapses are aroused quickly or slowly that the consciousness of recognition enters into consciousness than in maintaining that when certain cells or synapses are aroused certain ideas enter consciousness.

We should distinguish cognition from feeling, to use these old terms, by saying that when the object is presented a second time, the cognition is the result of certain pathways that are aroused,—that it covers the total reaction of the organism to the stimulus; but that the feeling is the result of the ease with which the reaction is made. If every time an electric current passed over a wire it reduced the resistance then we could express the above by this analogy. When a sending key is struck the answering click of the receiving key would

²⁰ See in this connection, E. L. Woods, *An Experimental Analysis of the Process of Recognizing*. *Amer. Jour. Psychol.*, XXVI, 1915, 313-387. Miss Woods presents two objections to the facilitation theory. First, "It helps us not at all on the side of consciousness," and second, "the most facile processes,—the processes which accompany those daily, habitual experiences to which our reactions are all but automatized,—do not bring with them the peculiar experience of familiarity." We believe we have answered the first objection in the paragraph accompanying this note. We would emphatically deny the truth of the second objection. We believe there is a characteristic feeling of 'at-homeness' which accompanies perception of very familiar objects. We would admit, however, that because of the fact that attention is seldom directed to habitual performances this feeling is seldom specifically noted. But it is possible to so note it, if one chooses. Possibly homesickness is nothing but the loss of this affective element so common in our lives and so little attended to ordinarily, until it is absent.

correspond to the idea or ideas aroused, would be the reaction; but the heating of the wire due to its resistance to the current would correspond to the feeling. As the heating becomes less and less with the lessening resistance, so the

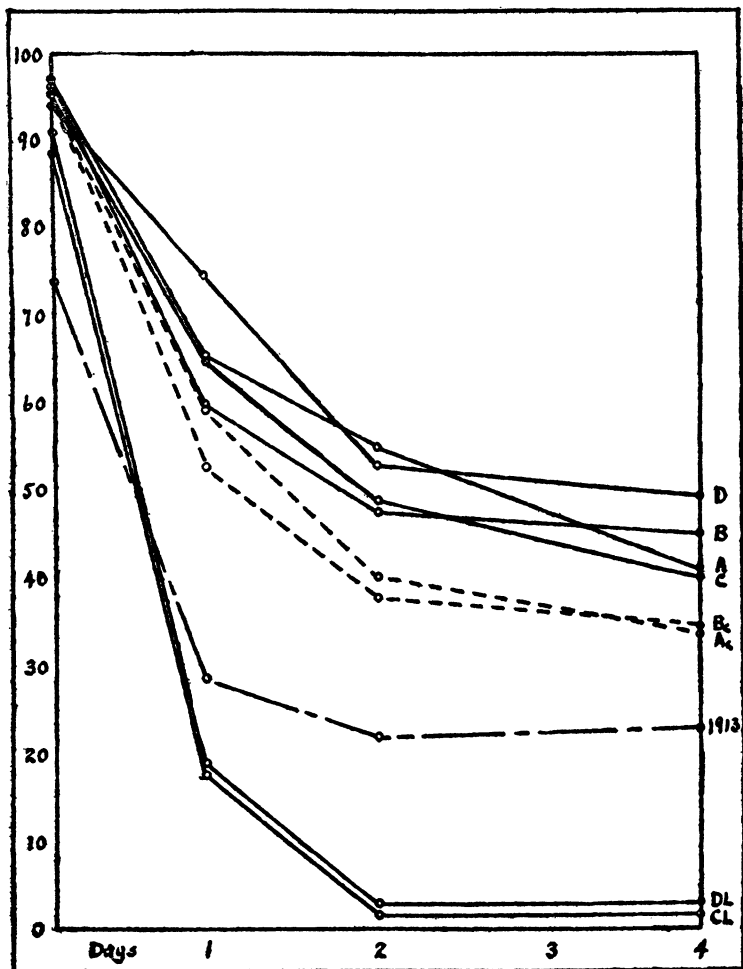


PLATE I.—Subject *A*. Curves A, B, C, D, present recognition memory data (uncorrected for chance errors) from Experiments A, B, C, and D, respectively. Curves Ac and Bc present corrected data from Experiments A and B. Curve 1913 presents corrected data from 1913 article. Curves CL and DL present data on localization from Experiments C and D, respectively.

feeling would correspondingly change. And as different degrees of heat give off different colors, so different degrees of feeling could produce different types of awareness in consciousness, i. e., strangeness, recognition, "at-homeness."

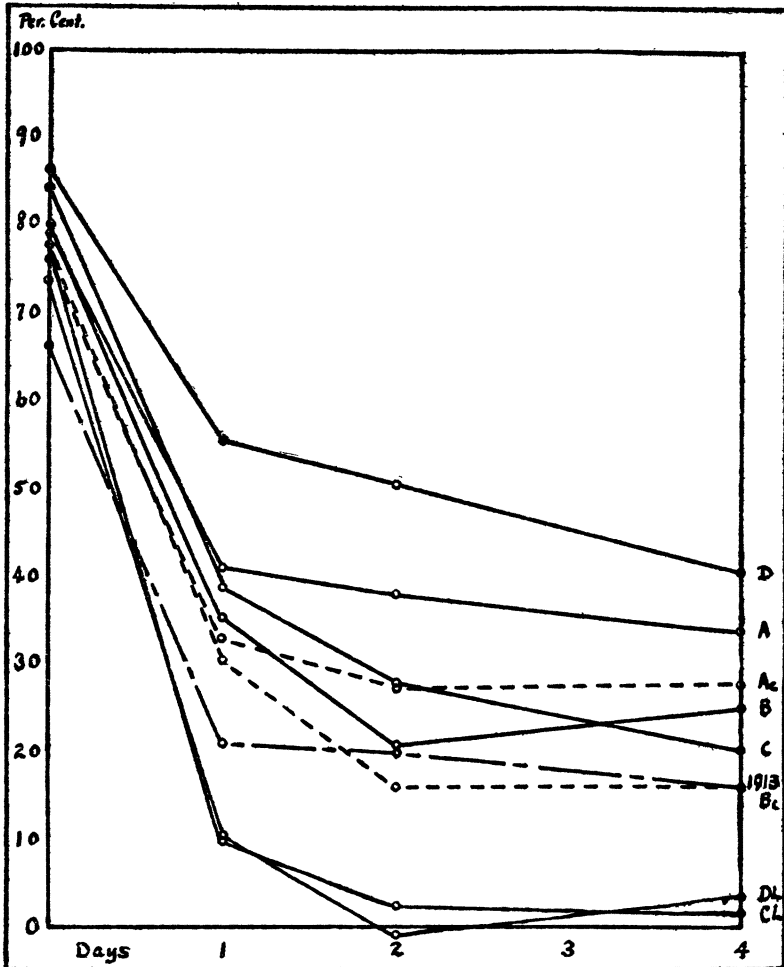


PLATE II. Subject *B*. Curves A, B, C, D present recognition memory data (uncorrected for chance errors) from Experiments A, B, C, D, respectively. Curves Ac and Bc present corrected data from Experiments A and B. Curve 1913 presents corrected data from 1913 article. Curves CL and DL present data on localization from Experiments C and D, respectively.

The whole controversy as to whether images must be present or not is answered by simply affirming that whether the discharge over the associational pathways results in the arousal of images or "imageless" thoughts is immaterial to the explanation of recognition. In fact we should be willing to add on the basis of our own introspections and those of others that this discharge might not be strong enough to bring any image or imageless thought into consciousness, but yet be sufficient to arouse the consciousness of recognition. It is not the reaction in thought or action that is important, it is the difference in ease of the nervous flow between this particular discharge and other discharges which determines whether familiarity or strangeness is present.

In running over such a classification of the theories of recognition as Miss Woods²¹ gives, it seems to us that the position maintained here includes most of the theories listed by her. Much of the controversy in the past over this subject has been between those who maintain that recognition is due to ease and those who maintain that recognition is due to some sort of fusion between the new percept and the old, or to the arousal of associations previously present. As we have already pointed out, we believe all these factors enter into the process of recognition. The object must be perceived as the same object it was previously perceived to be—there is then fusion of percept and image, if you wish to speak that way; there is the arousal again of the same associations previously aroused; and there is an increased facility of nerve functioning. All are necessary. Without the former the latter would not occur, but recognition itself is due to the latter,—is the conscious correlate of the ease-difficulty element.

Conclusion. Recognition is then due first of all to the fact that when an object is seen again it arouses the same associations that it did when it was first seen. The nervous current traverses the same pathways again that it did before. This condition is essential for recognition but it is not the explanation of the recognition itself. The recognition arises as a conscious awareness that the second discharge has flowed more easily than it would if it had been a discharge to a new object and it has flowed with more difficulty than if it had been a discharge to an old familiar object. This ease may be measured objectively in reaction-time. It is estimated subjectively in terms of consciousness of strangeness or familiarity.

²¹ E. L. Woods, *op. cit.*

2. *Concerning the Nature of Localization.* From our data it appears that one can localize words in the 5 minute interval list practically as accurately as he can recognize the same words, but that this ability to localize fades out very much more rapidly with the lapse of time than does the correspondingly ability to recognize.

The two writers are disagreed, however, as to whether the loss in localization ability is due actually to the lapse of time, as in recognition or recall memory, or whether it is due to the fact that localizations cannot be distinguished between lists of varying ages, except in the one case when the last list is concerned. The second writer believes that to the extent that one can localize, which according to our data is practically nil after a two day interval, it can be done in some way or other by estimating the strength of some mental process and so assigning the length of time since the object was seen before. The first writer believes that one can only estimate the strength of such a mental process as being in a given case the strongest of all or the next strongest, and that beyond that one cannot go.

Both writers are agreed, on the other hand, that localization is akin to recognition in being primarily such a state of consciousness as is included under the head—*affective*. It may involve more than this. It is recognized also, as pointed out above in the introspections, that localization may be made at times on the basis of associations which link the particular object to other objects whose time relations are known. But such localizations with us were introspectively different from those based on mere awareness that the word had been seen in such and such a list. We should say, then, that a person is capable of being conscious (1) that he has seen an object before and (2) that he has seen this object not recently, but some time ago, or vice versa. Possibly this second ability is based on some sort of an estimation of the strength of the process which produces the consciousness of recognition.

From all of our experiments and from those of Feingold it is clear that one seldom identifies a new object as having been seen previously. The consciousness of strangeness is clear and unmistakable. In terms of our theory the ease-difficulty element involved in a first discharge is quite different from that element as involved in a second or third discharge. And as we know from studying learning curves that the greatest drop in reaction-time is between the first and second trial and that with each successive trial the drop becomes less and less, so here we may liken the consciousness

between strangeness and familiarity as due to a large difference in the ease-difficulty element, whereas when it comes to estimating the amount of familiarity, and possibly this is what localization as a feeling is, we have an increasingly difficult task due to the smaller and smaller actual changes in the ease-difficulty element with each successive reaction to the given object (or in terms of the forgetting curve, we would have correspondingly an increasingly difficult task due to the smaller and smaller actual changes in the ease-difficulty element with each succeeding unit of time). If this hypothesis is true (and we are not at all sure that it is), localization is not a qualitatively different type of consciousness from recognition, but is a finer subjective analysis of the consciousness of recognition. That is, when we recognize we are roughly aware that the associational discharge has flowed easier than it would in response to a new object. When we localize we estimate very carefully the amount of this "ease" element and in terms of it say we have seen this object recently or a long time ago.